RM Cell Test Chip Photomicrographs

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Document Description

This slide deck gathers, for purposes of public exhibition, selected photomicrographs of superconducting microcircuits on the first test chip produced by the ongoing effort at Sandia informally called "BARCS" (Ballistic Asynchronous Reversible Computing with Superconductors). This effort spans two formal projects:

"Asynchronous Ballistic Reversible Computation with Superconducting Josephson Junctions,"

- an internally funded project which ran from 2017-2020.

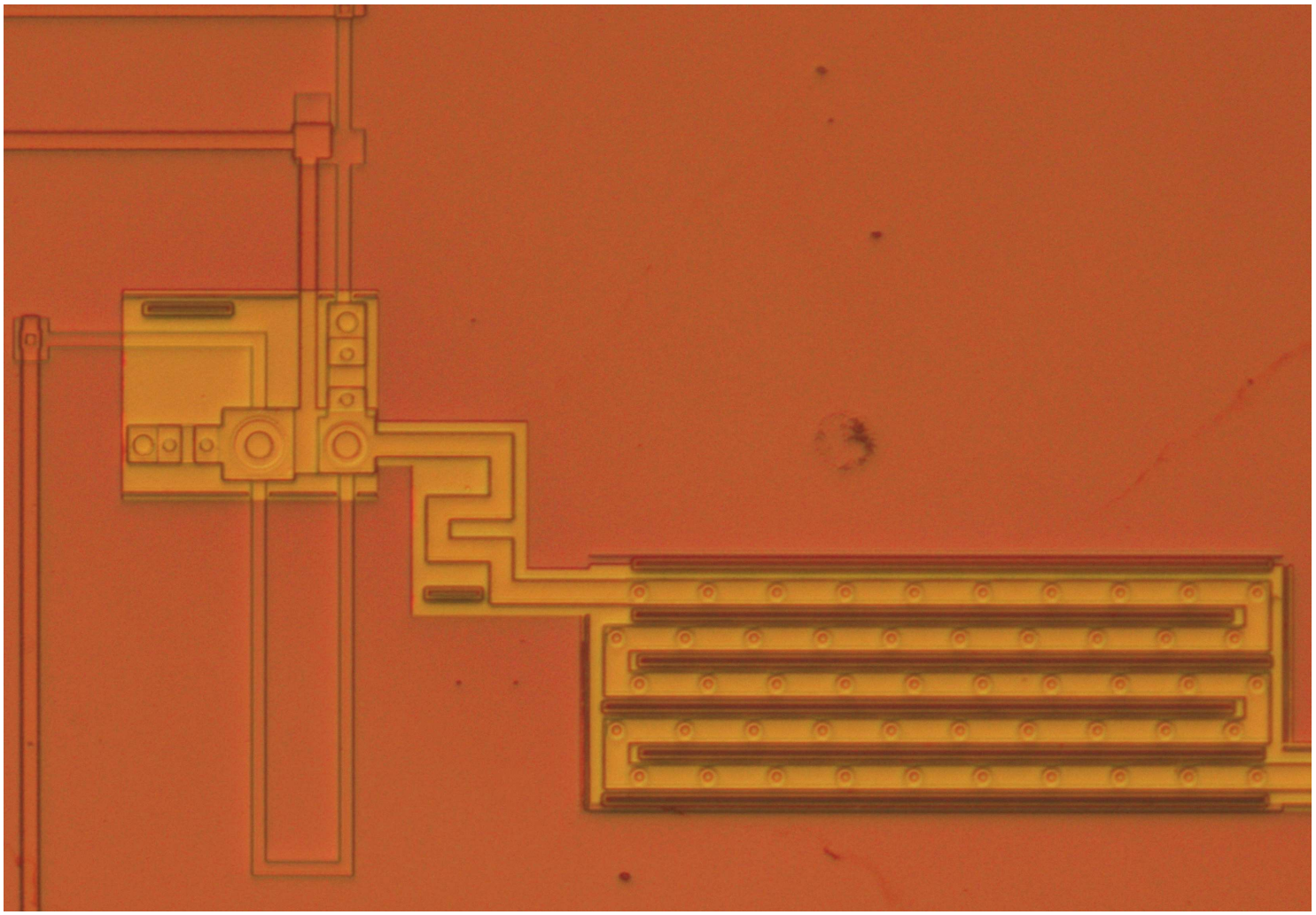
"Asynchronous Ballistic Reversible Computing with Superconducting Elements,"

- an externally funded project which started in 2020.

The circuits shown were designed in 2019-2020 using internal funding, and fabricated with support from the external sponsor. Additional information about the goals of this effort, and these particular circuits, can be found in the bibliography on the last slide, and at

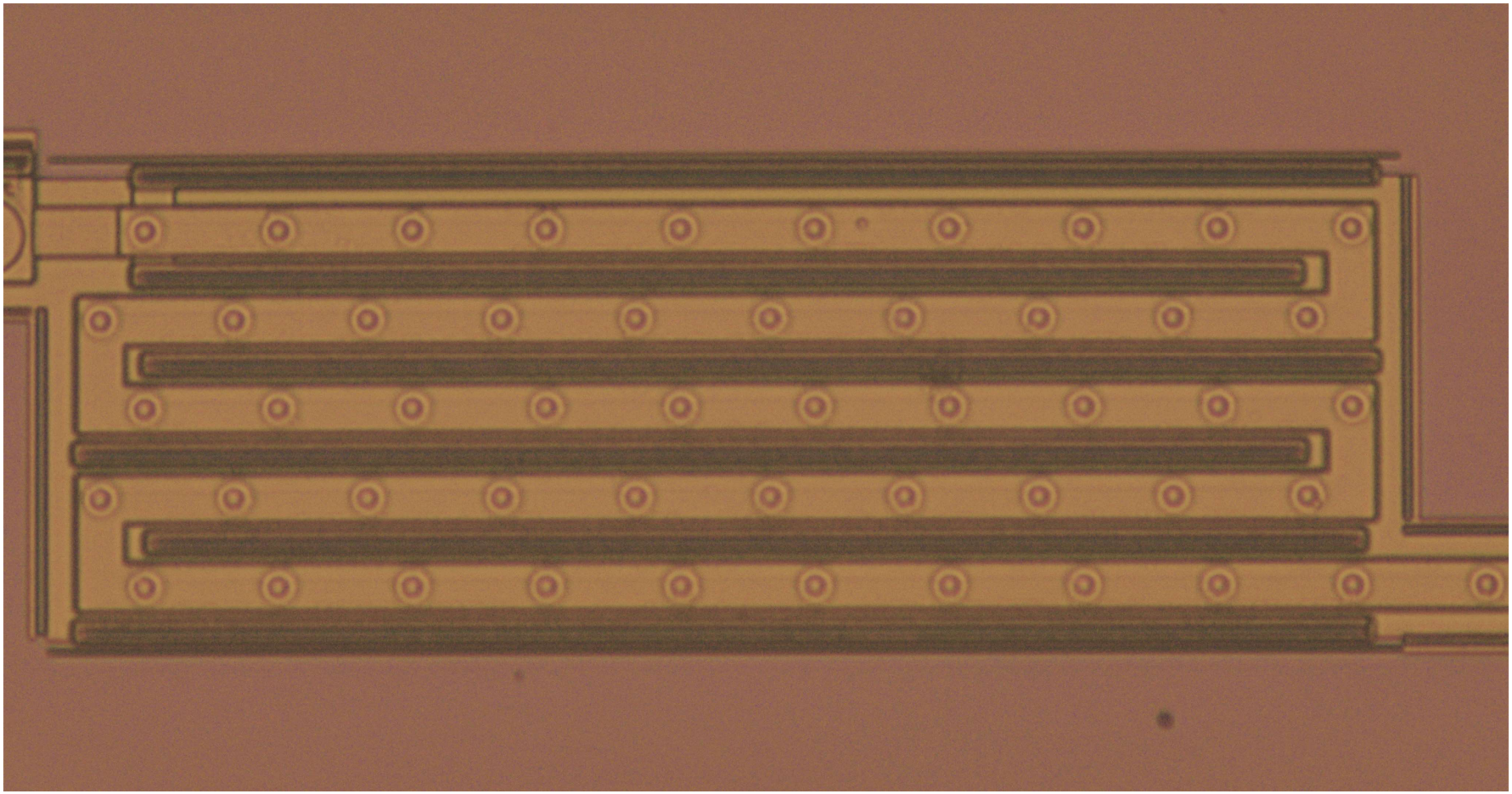
http://www.cs.sandia.gov/cr-mpfrank

DC-to-SFQ Converter Feeding dLJJ Ballistic Interconnect



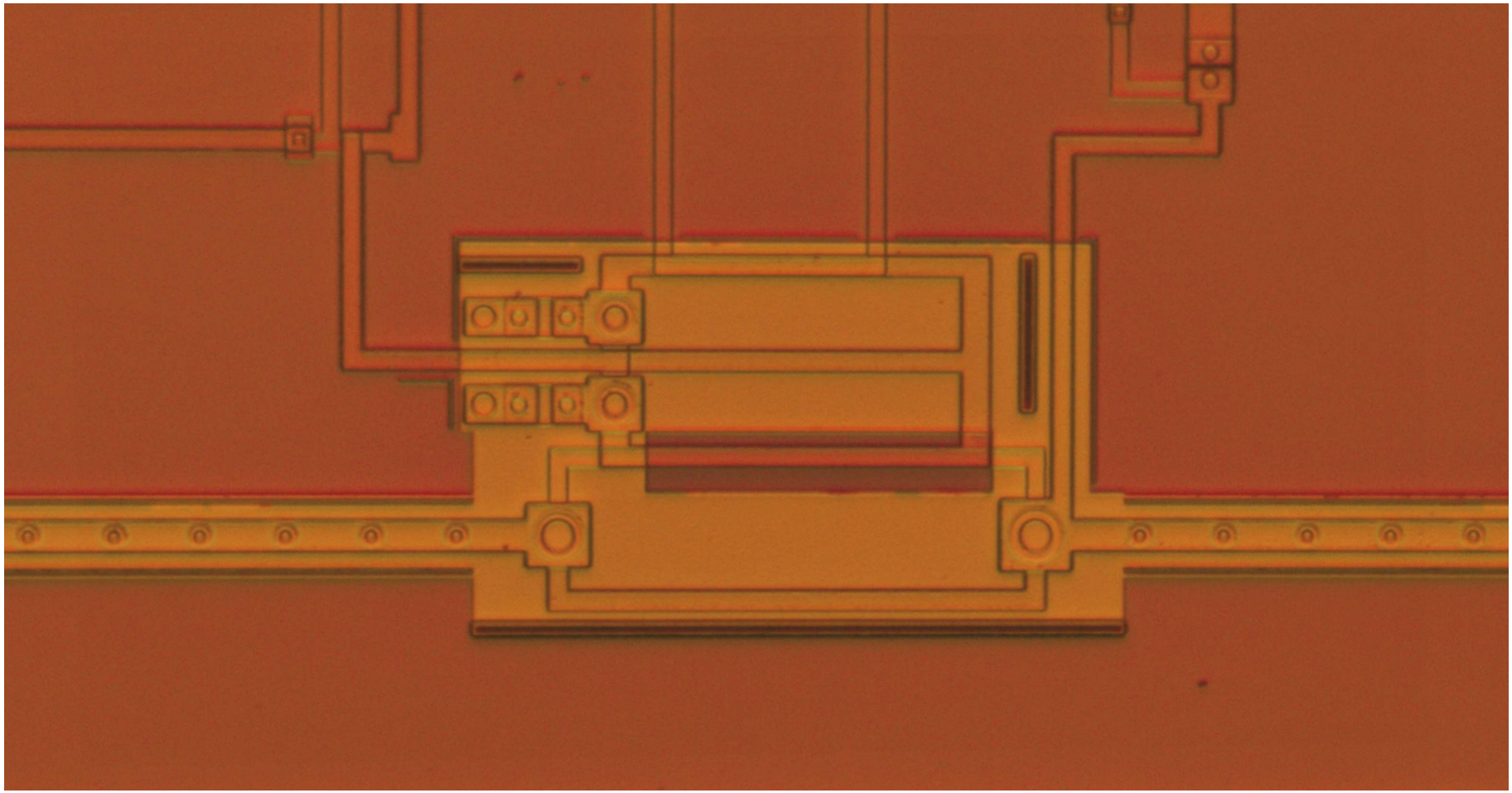
Photomicrograph of a portion of the test circuit for the RM cell. At left is a simple DC-to-SFQ converter circuit designed by Rupert Lewis. This feeds a stripline inductor which broadens the SFQ pulse, matching the pulse width for input to the discrete Long Josephson Junction (dLJJ), the S-shaped structure at lower right, which is folded up in this design for compactness. This delivers the input fluxon to the RM cell (not shown in this image.) Approved for public release, SAND2020-8005 O.

Discretized Long Josephson Junction (dLJJ) Interconnect—A Nonlinear Transmission Line for Flux Soliton Transport



Close-up photomicrograph of a discretized Long Josephson junction (dLJJ) included in our test circuit for the RM cell. (Layout by Nancy Missert.) The small dots are nominally 15 μA critical current unshunted junctions connecting the upper stripline to a current return stripline underneath. The full structure shown here includes 51 such junctions. The width of the fluxon is approximately 10-11 unit cells, so, about equal to the width of the structure. Approved for public release, SAND2020-8005 O.

Reversible Memory (RM) Cell With Measurement SQUID and Reset Circuit



Reversible memory (RM) cell and testing circuitry. The yellow line coming from lower left is the input dLJJ, and the flattened box shaped structure that it connects to (lower center) is the RM cell itself (storage loop). The "entrance" JJ on its left side is nominally about 75 μA. The figure-8 structure overlapping the RM cell is a SQUID (superconducting quantum interference device) that is mutually inductively coupled to the RM cell (within the dark cutout area); this is added for purposes of measuring the stored flux. At the right side of the RM cell is a ~100 μA JJ which may be externally pulsed, which allows any stored flux to be "flushed" out of the cell (and emitted down the LJJ to lower right), providing another method of readout via an SFQ-DC converter (not shown), and also resetting the cell to a null (0 flux) state to prepare it for a new testing sequence. Approved for public release, SAND2020-8005 O.

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